# ROLE OF WATER IN PREBIOTIC NITROGEN CYCLES

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## INTRODUCTION

Hydrothermal systems have been hypothesized as locations for the genesis of life. However, few experiments have been conducted that examine the interplay of biologically important compounds with minerals associated with these systems. One element generally neglected un the study of prebiotic chemistry is nitrogen. Several key questions in the study of the early Earth's nitrogen cycle are: How and under what conditions was reduced nitrogen formed? How was this reduced nitrogen incorporated into organic compounds, and what were the important parameters controlling the stability of these nitrogen containing organic compounds? A series of high pressure-hydrothermal reactions were undertaken to investigate these questions.

## EXPERIMENTAL

Experiments were undertaken using a sealed gold tube (Kullerud & Yoder 1959) method. Samples were placed inside prewashed, combusted 99.95% pure Au gold tubes (10mm x 2 mm), followed by freezing and sealing of both ends by arc-welding. The sealed capsules were incubated at known temperature and pressure by use of an internally heated gas pressure device (Yoder 1950). After incubation, samples were frozen in liquid $N_2$, opened and extracted. Sample analysis for inorganic nitrogen was done by spectrophotometric methods (Strickland and Parsons, 1972), analysis for amino acids was done by ion-exchange HPLC followed by OPAH post-derivitization, and other organic compounds were analyzed by routine GC-MS techniques.

## RESULTS AND DISCUSSION

The results for nitrogen gas reduction are shown in Figures 1 & 2. The amount of nitrogen reduction was significantly affected by the amount of water present in the system, with little observable $N_2$ reduction under hydrothermal conditions in the presence of excess water. This is hypothesized to occur because of the preferential binding of O to the catalytic FeO surface, preventing the binding of $N_2$ gas.

The role of water in the reductive amination of pyruvic acid, considered an essential step in early biochemical cycles, was investigated. The results (Fig. 3) indicate that the reaction only takes place in high yield at water:pyruvic ratios of 100:1 or greater. Finally, the stability of amino acids in hydrothermal systems was investigated. Our initial results indicate that certain common hydrothermal minerals have the ability to extend the stability of amino acids by many orders of magnitude.

## REFERENCES

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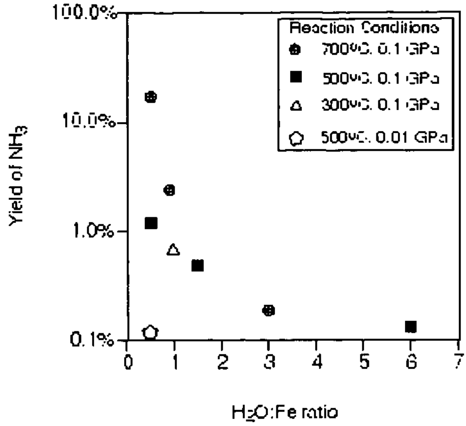


Figure 1. Production of ammonia from $N_2$ in the Fe:$H_2O$ system

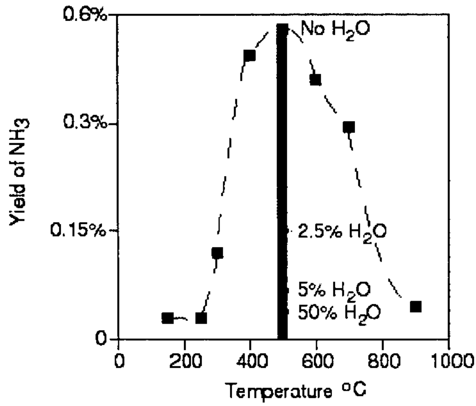


Figure 2. Production of ammonia from $N_2$ in the $Fe_3O_4$:$H_2CO_2$ system

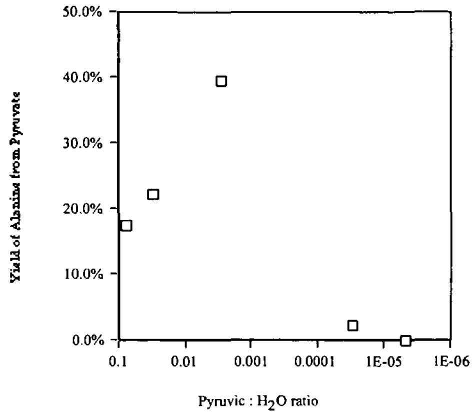


Figure 3. Effect of dilution upon reductive amination of pyruvate to form alanine